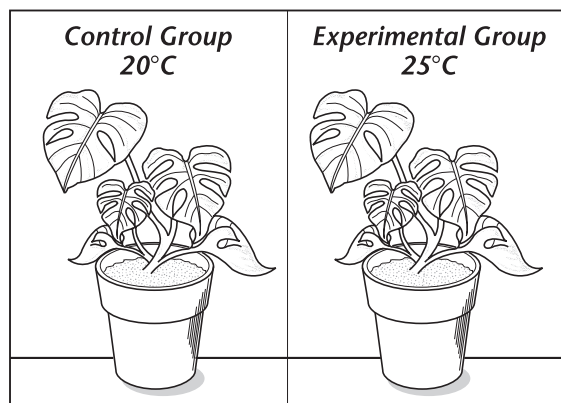


SKILLS INTRODUCTION**Controlling Variables**

Suppose that you are planning to try out for the track team. To make the team, you need to increase your speed. You wonder whether to eat a new cereal being advertised for athletes. You could eat the cereal every morning for a month, then run a timed race. If your new time was faster than your previous time, would the cereal be the cause? Based on your test, there'd be no way to know! Too many factors could explain your improved speed. The only way to be sure whether a particular variable causes a specific result is to conduct a controlled experiment.

Every experiment involves several variables, or factors that can change. For example, consider this question: Will houseplants grow faster if you make the room warmer? To answer this question, you decide to grow plants at different temperatures. The variable that you purposely change and test— the temperature of the room— is called the **manipulated variable**. The factor that may change as a result of the manipulated variable— how fast the plants grow— is called the **responding variable**.

An experimental plan is not complete unless the experimenter controls all other variables. **Controlling variables** means keeping all conditions the same except for the manipulated variable. In an experiment on temperature and plant growth, for example, you have to control any other variables that might affect the growth rate. Such variables include the size of the container, the type of soil, the amount of water, the amount of light, and the use of fertilizer. In addition, you would need to use identical plants in the experiment.



*Same kinds of plants
Identical containers
Same type and amount of soil
Same type and amount of fertilizer
Same amount of water
Same lighting*

When all these variables are controlled, you can logically conclude that the differences in your results are due to changes in the manipulated variable.

Controlling Variables (*continued*)

How to Identify the Control Group In a controlled experiment, scientists usually study groups of living or nonliving things instead of comparing just two individual things. The groups that are being studied are called the experimental group and the control group. The experimental group is the group whose conditions are being changed. In the example on the previous page, the plants being grown at the warmer temperature of 25°C make up the experimental group. The control group, or the control, is the group whose conditions are *not* being changed. In the example, the plants grown at the usual temperature of 20°C make up the control group.

The purpose of the control group is to serve as a standard of comparison. For example, if the plants in the control group grew an average of 1 centimeter after 3 weeks, you could compare whether the plants in the experimental group grew the same amount, or grew more than or less than 1 centimeter.



Tips for Controlling Variables

- ◆ Start by describing the question or process being investigated. Then identify the manipulated variable and the responding variable in the investigation. Predict the kinds of results you might observe in the responding variable.
- ◆ Create a list of all of the other variables that might affect the responding variable.
- ◆ Consider whether you have forgotten any of the most common types of variables: time, temperature, length, width, height, mass, volume, number, and the kinds of substances being used in the experiment.
- ◆ Determine whether or not one of the objects or groups of objects will serve as the control.

✓ **Checkpoint** Why must variables in an experiment be controlled?

SKILLS PRACTICE

Controlling Variables

Answer the following questions in the space provided. Use the back of this sheet if you need more space.

1. You are planning an experiment to find out whether the rate at which water freezes depends on the shape of its container. Identify the manipulated variable and the responding variable. List the other variables you would control.

2. Researchers want to determine the best temperature for storing batteries. Describe a possible experiment and list the variables to be controlled in that experiment. Be sure to identify the manipulated and the responding variables.

3. Your friend has to plan an experiment for a science fair. He asks for your help. His topic is "The Strongest Cloth for Backpacks." What variables must his experiment include? What variables must be controlled?

4. Suppose you wanted to compare two different stain removers to learn which one was better at removing food stains from clothing. In your test, what variables would you need to control?

5. **Think About It** Some classmates conducted an experiment to find out which brand of paper towels is the strongest. You find out that they didn't try to control any variables. Write a few sentences explaining why they cannot draw any useful conclusions from their experiment.

